

CLAIMS

1. A power circuit for a battery comprising:
a first energy storage source;
a second energy storage source connected in series with the first energy storage source;
a DC/DC converter for converting an electric power between the first energy storage source and the second energy storage source;
and
control means for controlling the DC/DC converter,
wherein the control means detects a voltage of one of the energy storage source that is disposed on a high voltage side, from among the first and second energy storage sources which are connected in series with each other, and
wherein, when the detected voltage is lower than a predetermined first threshold voltage, the control means charges the energy storage source disposed on the high voltage side with electricity through the DC/DC converter.

2. A power circuit for a battery according to claim 1, wherein the control means detects the voltage of the energy storage source disposed on the high voltage side, and when the detected voltage is lower than the first threshold voltage, keeps an engine running and does not perform an engine stopping operation.

3. A power circuit for a battery according to claim 1, wherein the control means detects the voltage of the energy storage source disposed on the high voltage side, and when the detected voltage is lower than the first threshold voltage, charges the energy storage source disposed on the high voltage side with electricity through the DC/DC converter while keeping an engine running, and when the detected voltage is higher than the first threshold voltage, stops the engine.

4. A power circuit for a battery according to any one of claims 1 to 3, wherein the control means detects a voltage of the first energy storage source and a voltage of the second energy storage source, and adjusts a value of the first threshold voltage in accordance with a value of the voltage of the energy storage source that is disposed on a low voltage side from among the first and second energy storage sources.

5. A power circuit for a battery connected to an electric motor through an electric conversion circuit comprising:

a first energy storage source;

a second energy storage source connected in series with the first energy storage source;

a DC/DC converter for converting an electric power between the first energy storage source and the second energy storage source;

and

control means for controlling the DC/DC converter,
wherein, when the electric motor in a stop state is started, the control means detects a voltage of the energy storage source that is disposed on a high voltage side, from among the first and second energy storage sources which are connected in series with each other, and adjusts an output electric power of the DC/DC converter in accordance with a value of the detected voltage.

6. A power circuit for a battery according to claim 5, wherein the control means detects a voltage of the energy storage source that is disposed on a low voltage side, from among the first and second energy storage sources which are connected in series with each other, and when a value of the detected voltage is equal to or smaller than a predetermined second threshold voltage, controls an output of the DC/DC converter so that a current of the energy storage source disposed on the low voltage side becomes minimum.

7. A power circuit for a battery according to any one of claims 1 to 4, wherein the control means detects a voltage value of the energy storage source disposed on a low voltage side from among the first and second energy storage sources which are connected in series with each other, and when the voltage value is smaller than a predetermined third threshold voltage, increases a value

of the first threshold voltage.

8. A power circuit for a battery, comprising:

a first energy storage source;

a second energy storage source connected in series with the first energy storage source, the second energy storage source having an allowable input current larger than a permissible input current of the first energy storage source;

an electric power conversion circuit for converting an electric power between an electric motor which is connected to an axle of a vehicle and the first energy storage source and the second energy storage source that are connected in series with each other;

a DC/DC converter for converting an electric power between the first energy storage source and the second energy storage source; and

control means for controlling the DC/DC converter,

wherein the control means includes DC/DC converter control means for, when a regenerative electric power of the electric motor is charged to the first energy storage source and the second energy storage source through the electric power conversion circuit, controlling the DC/DC converter so that an input current to the first energy storage source becomes equal to or smaller than the permissible input current of the first energy storage source.

9. A power circuit for a battery according to claim 8 further comprising:

a vehicle speed sensor for detecting a vehicle speed of a vehicle;

a braking command unit for issuing a braking command in accordance with which braking is applied to the vehicle with a desired braking force; and

a first voltmeter for detecting a terminal voltage of the first energy storage source,

wherein the control means comprises:

input current calculation means for calculating a regenerative energy generated by the electric motor during the electric power regeneration based on the detected vehicle speed and the braking force, and for calculating an input current with which the regenerative energy is charged to the first energy storage source and the second energy storage source without carrying out electric power shift in the DC/DC converter; and

allowable input current calculation means for obtaining an SOC of the first energy storage source based on a terminal voltage of the first energy storage source to calculate an allowable input current of the first energy storage source based on the SOC; and

when the regenerative electric power of the electric motor is charged to the first energy storage source and the second energy storage source through the electric power conversion circuit, the

DC/DC converter control means controls, when the input current obtained from the input current calculation means is larger than the allowable input current obtained from the allowable input current calculation means, the DC/DC converter so that the electric power is shifted from the first energy storage source to the second energy storage source.

10. A power circuit for a battery according to claim 9, wherein, when the regenerative electric power of the electric motor is charged to the first energy storage source and the second energy storage source through the electric power conversion circuit, the DC/DC converter control means controls, when the input current obtained from the input current calculation means is not larger than the allowable input current obtained from the allowable input current calculation means, the DC/DC converter so that the electric power is shifted from the second energy storage source to the first energy storage source.

11. A power circuit for a battery according to claim 8 further comprising:

a vehicle speed sensor for detecting a vehicle speed of a vehicle;

a braking command unit for issuing a braking command in accordance with which braking is applied to the vehicle with

a desired braking force; and

a first voltmeter for detecting a terminal voltage of the first energy storage source;

wherein the control means comprises:

input current calculation means for calculating a regenerative energy generated by the electric motor during the electric power regeneration based on the detected vehicle speed and the braking force, and for calculating an input current with which the regenerative energy is charged to the first energy storage source and the second energy storage source without electric power shift in the DC/DC converter; and

wherein, when the regenerative electric power of the electric motor is charged to the first energy storage source and the second energy storage source through the electric power conversion circuit, the DC/DC converter control means controls, when the input current obtained from the input current calculation means is larger than a predetermined value set in advance, the DC/DC converter so that the electric power is shifted from the first energy storage source to the second energy storage source, and controls, when the input current obtained from the input current calculation means is equal to or smaller than a predetermined value set in advance, the DC/DC converter so that the electric power is shifted from the second energy storage source to the first energy storage source.

12. A power circuit for a battery according to any one of claims 9 to 11 further comprising:

a second voltmeter for detecting a terminal voltage of the second energy storage source; and

a brake mechanism connected to an axle of the vehicle for mechanically braking rotation of the axle; and

wherein the control means comprises:

regeneration-enabling electric power calculation means for, when the electric power is shifted at maximum from the first energy storage source to the second energy storage source through the DC/DC converter, calculating a regeneration-enabling electric power that can be regenerated in the first energy storage source and the second energy storage source based on the terminal voltage of the first energy storage source and the terminal voltage of the second energy storage source; and

mechanical brake control means for, when the regenerative energy obtained from the input current calculation means is larger than the regeneration-enabling electric power, calculating a mechanical brake operation quantity based on a difference between the regenerative energy and the regeneration-enabling electric power, and for controlling the brake mechanism based on the mechanical brake operation quantity.

13. A power circuit for a battery according to claim 12, wherein

the second energy storage source has a capacitor, and when the regenerative electric power of the electric motor is charged to the first energy storage source and the capacitor through the electric power conversion circuit, the DC/DC converter control means controls the DC/DC converter so that an applied voltage becomes equal to or lower than an allowable applied voltage of the capacitor.